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1. Introduction

Five prototype models of the R. D. - 13 (Hotshot) miniature gasoline driven alternator were delivered to the Analysis and Appraisal Unit, Research and Development Branch for prototype inspection tests. Appropriate tests were conducted to determine whether the units meet the specifications of contract R. D. - 13.

2. Summary

The G. P. - 1 is a compact portable gasoline-driven alternator which weighs 12½ pounds when filled with gasoline. Its dimensions are 8x7½x6½ inches and its fuel capacity is 20 fluid ounces, sufficient for 3 hours running time. It is rated at 115 volts with a 100 watt, 80% lagging power factor load. The engine speed is 6000 r.p.m., and its terminal voltage is 400 cycle, single phase.

3. Mechanical Section

3.1. Description

The prime mover is a horizontally mounted Puchs-type 2 cycle, twin piston engine employing a float-type carburetor and a pressurized fuel tank. An impeller, keyed to the driveshaft between the engine and the alternator supplies forced air to cool the cylinder fins. Operation requires a knowledge of pull-rope starting with conventional choke and throttle controls. The mixture adjustment on the carburetor is very critical and has to be adjusted to each load for smooth and efficient operation of the unit.

3.2. Size and Weight

Length	8 inches
Width	6½ "
Depth	7½ "
Weight (with fuel)	12½ pounds

3.3. Accessories and Spares

The following accessories and spares were shipped with each G.P.-1.

Breaker points	1 set
Spark Plug	1 ea.
Muffer	1 ea.
Pull-Rope	1 ea.
Instruction Manual	1 ea.

3.4. Mechanical Tests

3.4.1. Fuel Tank Capacity

The gas tank capacity is 20 fluid ounces, sufficient for 3 hours operation with a 100 watt load.

3.4.2. Operating Temperatures

The following temperatures were recorded after the G.P.-1 had been delivering 100 watts for a period of 20 minutes.

Throttle control	130 °F
Choke control	110 °F
Top of unit	110 °F
Spark plug cover	270 °F
Carburetor	100 °F
Breaker point cover	150 °F
Muffer	420 °F
Exhaust air	225 °F
Exhaust gas	290 °F
Stationary breaker point	140 °F
Ambient temperature	75 °F

3.4.3. Sound Intensity

The sound level was measured at 6 feet using a General Radio type 759 B meter. The engine was rotated for maximum meter indication.

Measurement (condition)	Maximum Sound Intensity (db)
Ambient Noise	42
G.P.-1 without muffer	94
G.P.-1 with muffer	84

3.4.4. Life Test (Unit #4)

Prototype #4 was operated six hours per day at rated load to determine the life expectancy of the G.P.-1. Amoco Extra gasoline and Amoco paraffin base motor oil were mixed in a 14/1 ratio to be used as fuel during the test.

As with the other four prototypes, continuous operation for a period of time longer than three hours (except to refuel) is practically impossible. The throttle and mixture controls must be reset many times during this period in order to maintain speed.

At the conclusion of 39 hours running time the crankpin which is press-fit to the counterweight became loosened causing a distinct "knock" in the engine. During inspection it was also discovered that the piston rings on the exhaust piston had become "gummed" resulting in low compression.

The following log indicates the troubles encountered during the test.

Running Time (hours)	Trouble & Remedy
0	-------
3	The mixture control setting changed because of engine vibration. The control was reset.
7	The spark plug was coated with oxide and the breaker points were pitted. The plug was cleaned and the points were reset.
12	The engine would not run faster than 3200 r.p.m., because the exhaust ports were 95% clogged with carbon. The unit was dismantled the ports cleaned and the cylinder head and piston top surfaces were scraped free from carbon.
14	The engine was not stable. The carburetor was cleaned and adjusted.
20	Same as at 12 hours.
27	Same as at 12 hours.
30	The breaker points were badly pitted and had to be replaced.
34	Same as at 12 hours.
38	Same as at 12 hours.
39	Rings were gummed. Rings and exhaust piston were scored. Crankpin was loose causing a "knock."
	Test discontinued.

3.4.5. Mechanical Inspection (Unit #7, 4 hours running time).

Unit #7 was completely dismantled after 4 hours running time. The following observations were made during the break-down.

1. The aluminum spark plug housing is very flimsy. It could easily be damaged beyond repair while changing or cleaning the spark plug.

2. The breaker points were pitted more than could be reasonably expected after so short an operating period.

3. The breaker points were not concentrically aligned.

4. The fuel tank cap gasket leaks air pressure during operation.

5. Four flat head hexagon socket screws were damaged when removed and had to be replaced. Several Allen wrenches were stripped removing these screws.

6. The impeller was rubbing against the impeller housing. (Unit #4 and unit #7, the other units were not dismantled).

7. The impeller fits the driveshaft loosely. Shaft diameter 0.375 inches, Impeller inside diameter 0.3768 inches.

8. The carburetor float check valve was grooved. The carburetor ran dry when this valve malfunctioned during a test.

9. There was a 0.016 to 0.020 inch carbon deposit on the piston near the exhaust intake ports. The exhaust piston had a 0.010 inch deposit and the head had a 0.010 to 0.020 inch deposit in the vicinity of the spark plug.

10. The timing cam was not keyed to the driveshaft. It is a press fit and has to be set to within 15 degrees since that is the full amount of adjustment available.

11. The master-piston connecting rod was striking the crankcase.

12. The driveshaft bearing on the breaker-cam side of the crankshaft did not rotate freely.

13. The mounting holes in the spare breaker points had to be reamed out a few thousandths before they could be used. (Shaft diameter 0.252 inches, Bearing inside diameter 0.250 inches.)

4. Electrical Section

4.1. Description

4.1.1. Alternator

The alternator is driven directly by the engine crankshaft at a speed of 6000 R.P.M. A rotating 8 pole, keeper-stabilized, permanent magnet field induces a 115 volt, 400 cycle, single phase voltage in the stator windings. A panel-type line voltmeter on the front of the unit indicates terminal voltage at the output receptacle.

4.1.2. Ignition System

A line transformer with a great amount of leakage inductance is connected across the alternator output. The inherent regulatory action of this type transformer results in as much spark being developed at cranking speeds when the alternator is delivering 20 volts, as is developed at 6000 rpm when the output voltage is 115 volts.

The voltage from the secondary of this line transformer is rectified and applied to the storage capacitor. For each revolution of the engine, the breaker points close and discharge the capacitor into the spark transformer. Shortly after the points close, the current change in the primary is sufficiently great to cause a voltage to be generated in the secondary of great enough magnitude to arc over at the spark plug. The use of a capacitor across the points is unnecessary, the inductance of the primary being sufficiently large to prevent current flow at the instant of contact.

4.2. Electrical Tests

4.2.1. Terminal Voltage as a function of Load and Power Factor.

See curves #1, #2, #3, #4, and #5

4.2.2. Terminal Voltage as a function of Speed and Load.

See curves #6, #7, #8, #9, and #10

4.2.3. Speed regulation with fixed load

(Mixture adjusted at each load).

See curves #11, #12, #13, #14, and #15

4.2.4. Speed regulation with variable load.

(Mixture and throttle adjusted at a 75 watt load for a speed of 6000 R.P.M. and optimum running conditions).

Unit	Load (watts)	Speed (R.P.M.)	Terminal Voltage (volts)
5	50	6400	130
5	75	6000	120
	100	5200	104
	50	6800	136
6	75	6000	120
	100	5300	106
	50	6900	137
7	75	6000	120
	100	5400	110

4.2.5. Short circuit demagnetization test.

The generator output was short circuited for one second ten consecutive times. At each step terminal voltage was recorded.

No decrease in terminal voltage was experienced as a result of this test.

4.2.6. Radio Interference

4.2.6.1. Radiated interference

The radiated interference test was conducted in accordance with the JAN I 225 specification.

Measurements were made at a distance of one foot using the Stoddart NM-20-A field intensity meter.

See curve #16

4.2.6.2. Conducted Interference

Results indicate that conducted interference from the G.P.-1 is negligible. It averages 1.2 microvolts in the frequency spectrum between 150 kcs and 20 mcs.

5. Operation

The following procedure was found to be optimum when starting and operating the G.P.- 1.

(1) Fill with fuel mixture (14/1 gasoline to oil ratio), open the fuel sheet-off cock, and seat the gas tank cap firmly.

(2) Close the choke, open the throttle 1/3, and set the mixture control 1½ turns back from the full clockwise stop.

(3) Wind the pull rope on the starting pulley in the direction indicated by the arrow and "pull through" briskly 3 times.

(4) If the engine starts during step #3, and it normally does, the choke must be opened immediately and the load applied. It is possible to start the engine under load, but of course it is more difficult to pull it through.

(5) The mixture and throttle control should be set for smooth running with clean exhaust and a minimum of "popping" at a speed of 6000 R.P.M.

(6) As the engine reaches operating temperature after ten or fifteen minutes, step #5 must be repeated.

(7) With a 100 watt load it is possible to set the unit to a speed of 6000 R.P.M. by adjusting the throttle and mixture controls (as in step #5) until the panel voltmeter indicates 115 volts. With loads other than 100 watts a tachometer is required to set the throttle. However, it is possible to calibrate the voltmeter in terms of load. (For example : Prototype #4 : When the load is 50 watts, the voltmeter should indicate 123 volts, and at 75 watts it should indicate 119 volts.)

(8) Normal speed variation with a fixed load is from 200 to 600 R.P.M. amounting to roughly 4 to 13 volts. If the unit varies in excess of this amount, a finer mixture setting is required. At times, a rapid opening and closing of the throttle, followed by resetting this control will "clear the engine" and remedy the situation.

(9) When excessive flooding is experienced, the throttle should be closed, the spark plug removed, and the engine pulled through several times.

5. Operation (continued)

(10) When hot, the engine should be started with 2/3 rather than full choke.

(11) To stop the engine, the fuel shut-off should be closed and the throttle closed as soon as the engine slows down from lack of fuel.

(12) It is normal, though not desirable, for the choke and throttle controls to be extremely hot. Caution should be exercised not to allow the back of the hand to come in contact with the muffer, while adjusting the throttle. The muffer operates at a temperature of 420°F.

6. Conclusion :

Alternator

The alternator performance is acceptable. It has good regulation and suffered no demagnetization during the short circuit test.

It is strongly recommended that the following be stencilled on the outboard face of the rotor, "Caution - this is a keeper stabilized rotor."

Ignition System

The ignition system performed satisfactorily throughout the test with no spark failure. However, the ignition points were not in line, they became pitted after two hours operation, they bounced as a result of weak spring tension, and the copper conductor failed mechanically. The spare points had to be reamed before use. The spark plug housing on all five units suffered damage during the test.

It is recommended that the breaker point system be worked-over to clean up these mechanical difficulties and that the spark plug housing be made stronger.

Carburetor

The carburetor has been reworked extensively and simplified. As a result, there are ports, passageways, and adjustments not utilized. The mixture setting is very critical and requires a fine adjustment for each load. When the mixture is too rich, the exhaust ports become clogged and the unit has to be dismantled for cleaning. Occasionally the carburetor runs dry or floods when the check valve malfunctions.

It is recommended that the carburetor be re-worked so that the mixture setting is not so critical, and so that the float system operates reliably. During this rework, the excess ports, controls, etc., should be eliminated.

6. Conclusion (continued)

Engine

The engine proper is a manifestation of what can be done in the field of miniaturization. It is compact and lightweight. The crankshaft was found to be rubbing against the crankcase.

It is recommended that care be taken during manufacture to insure adequate clearance between the crankshaft and crankcase. The ignition timing cam should be oriented to the crankshaft with a key or a spline to facilitate breakdown and assembly of the unit.

General

The controls operate at too high a temperature, and the fuel tank leaks pressure at the cap.

7. Curves and Photographs

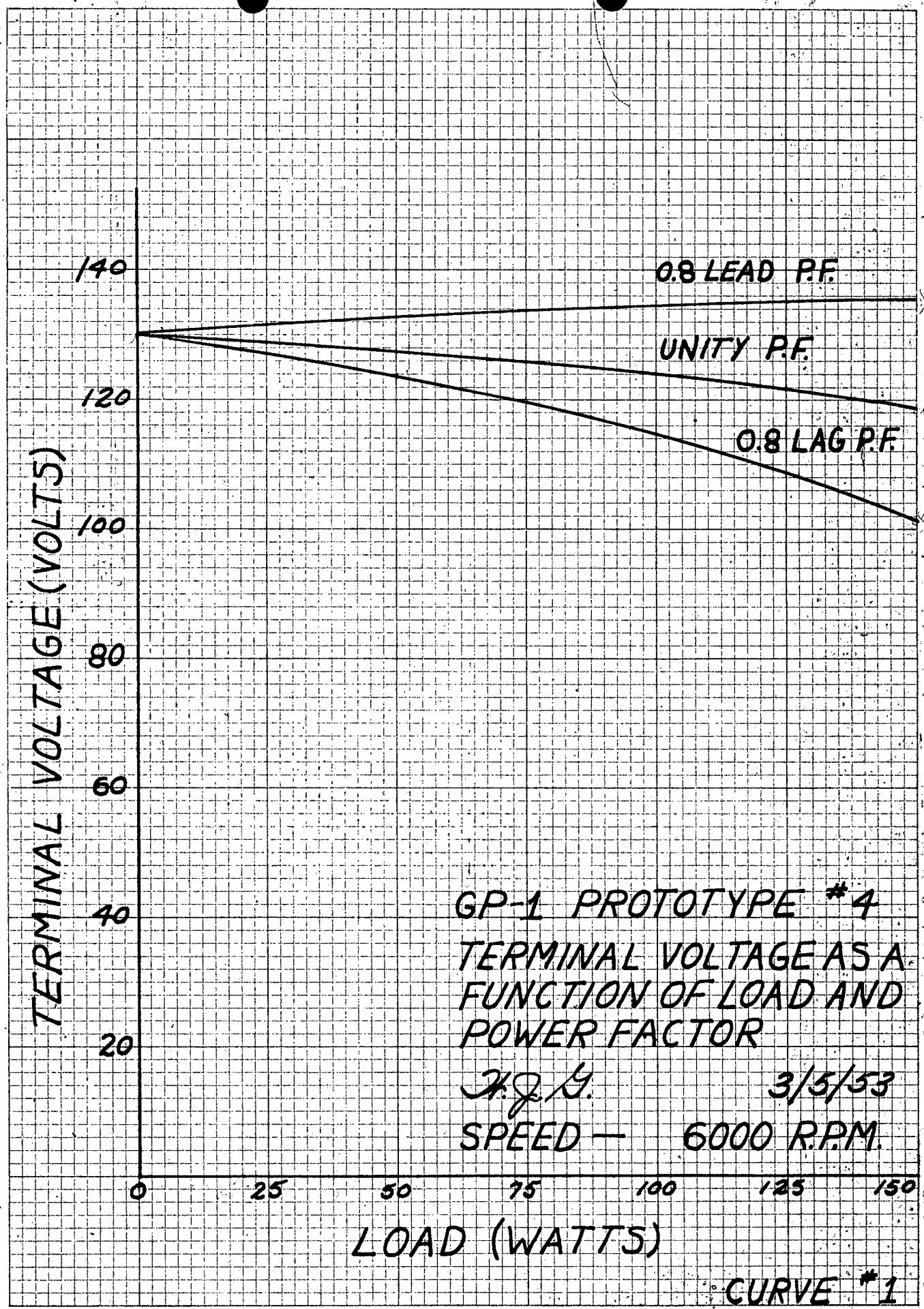
Photograph #1. A Front oblique view of the G.P.-1.

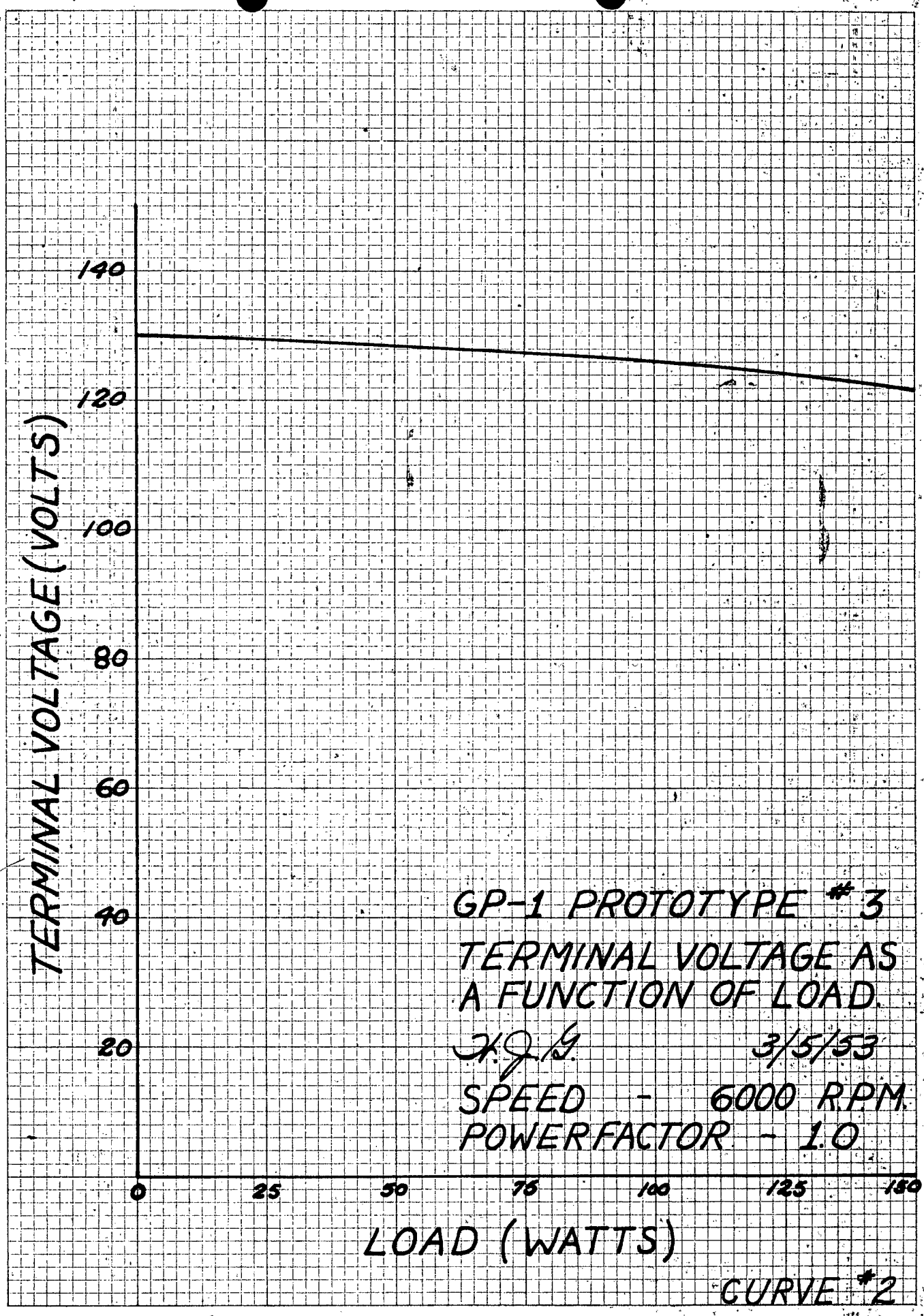
Photograph #2. A Rear oblique view of the G.P.-1.

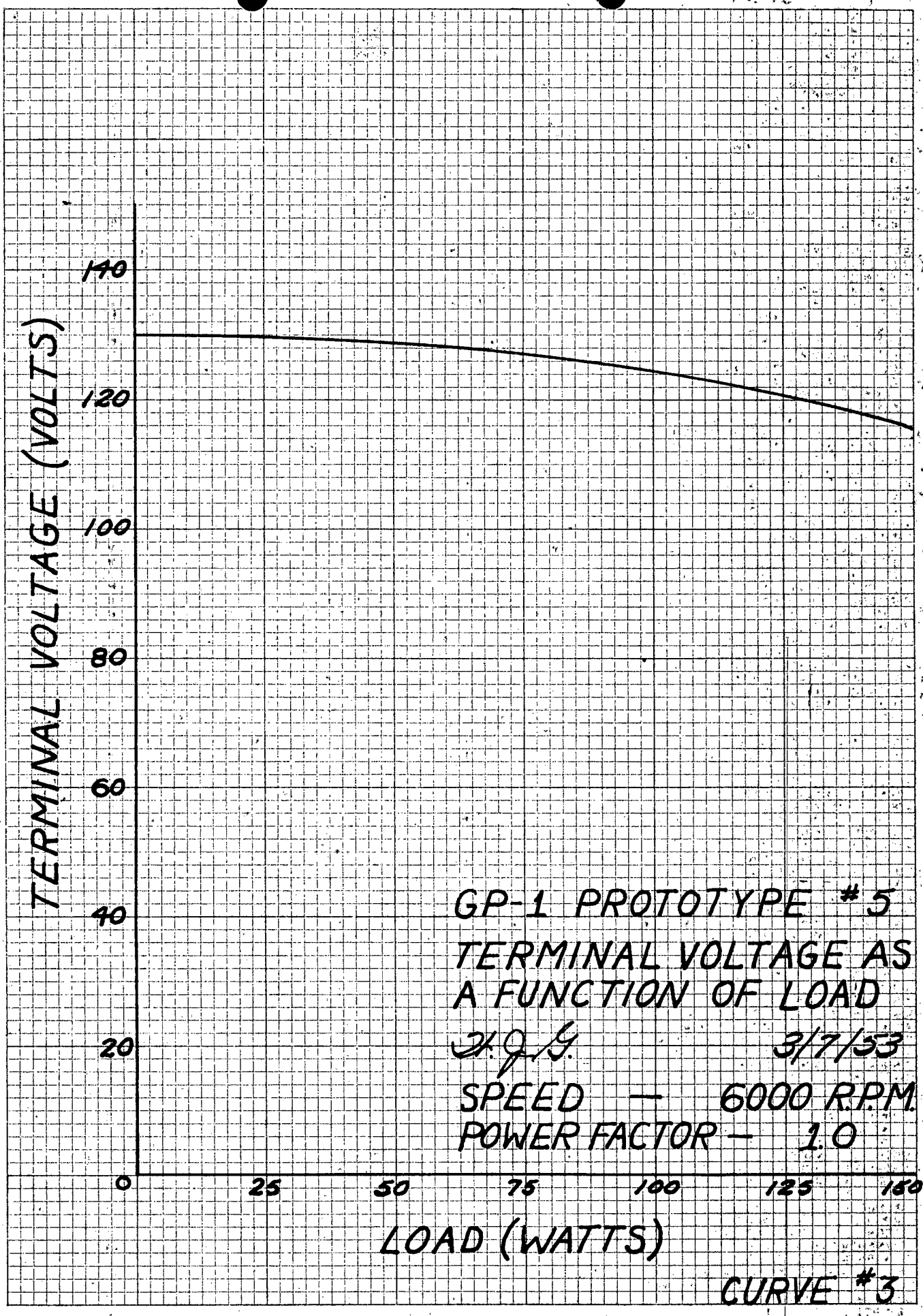
Photograph #3. A view of the piston and connecting rod assembly, showing the "gummed" rings and scored piston.

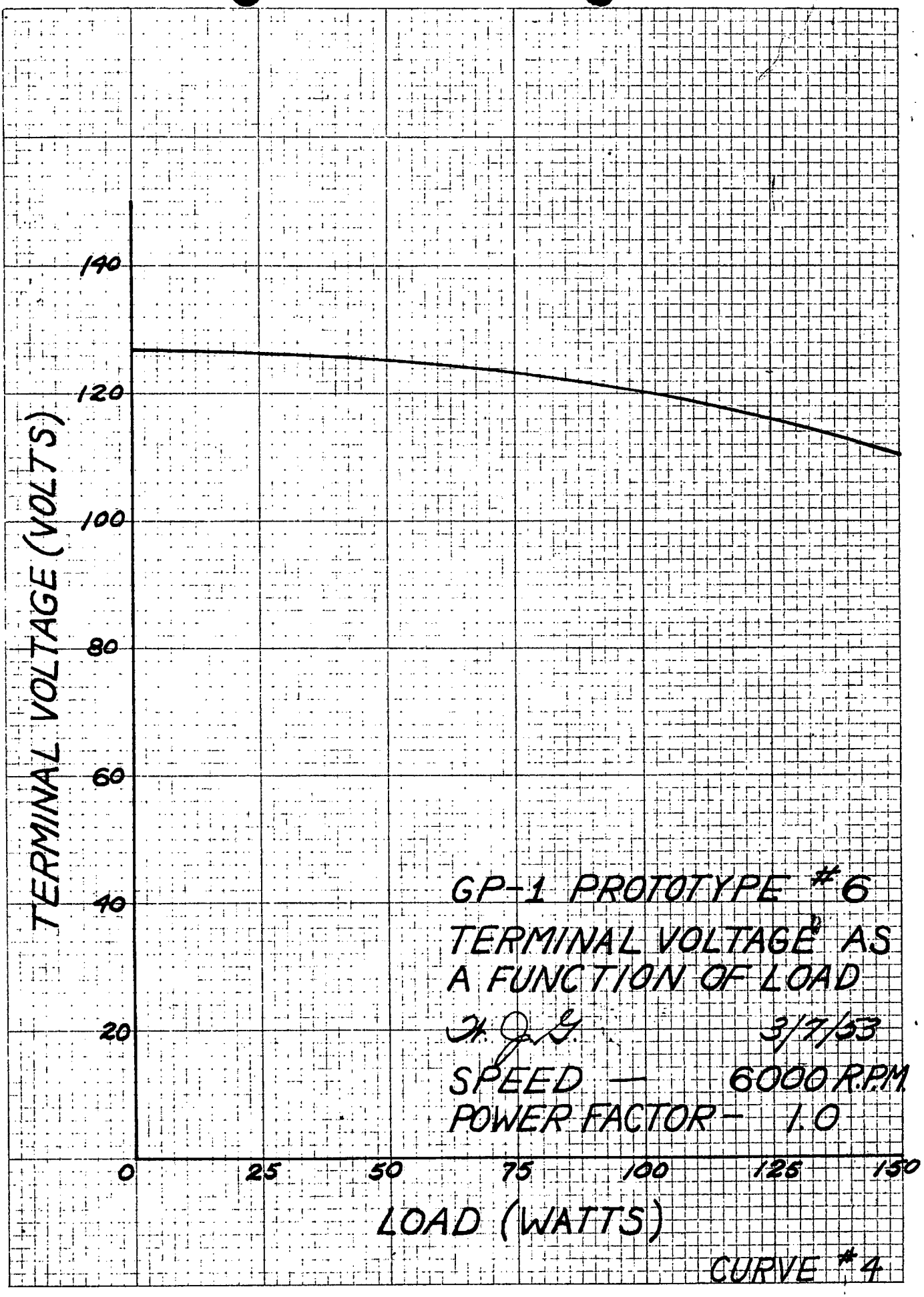
Photograph #4. A view of the separated crankshaft showing the loosened crankpin.

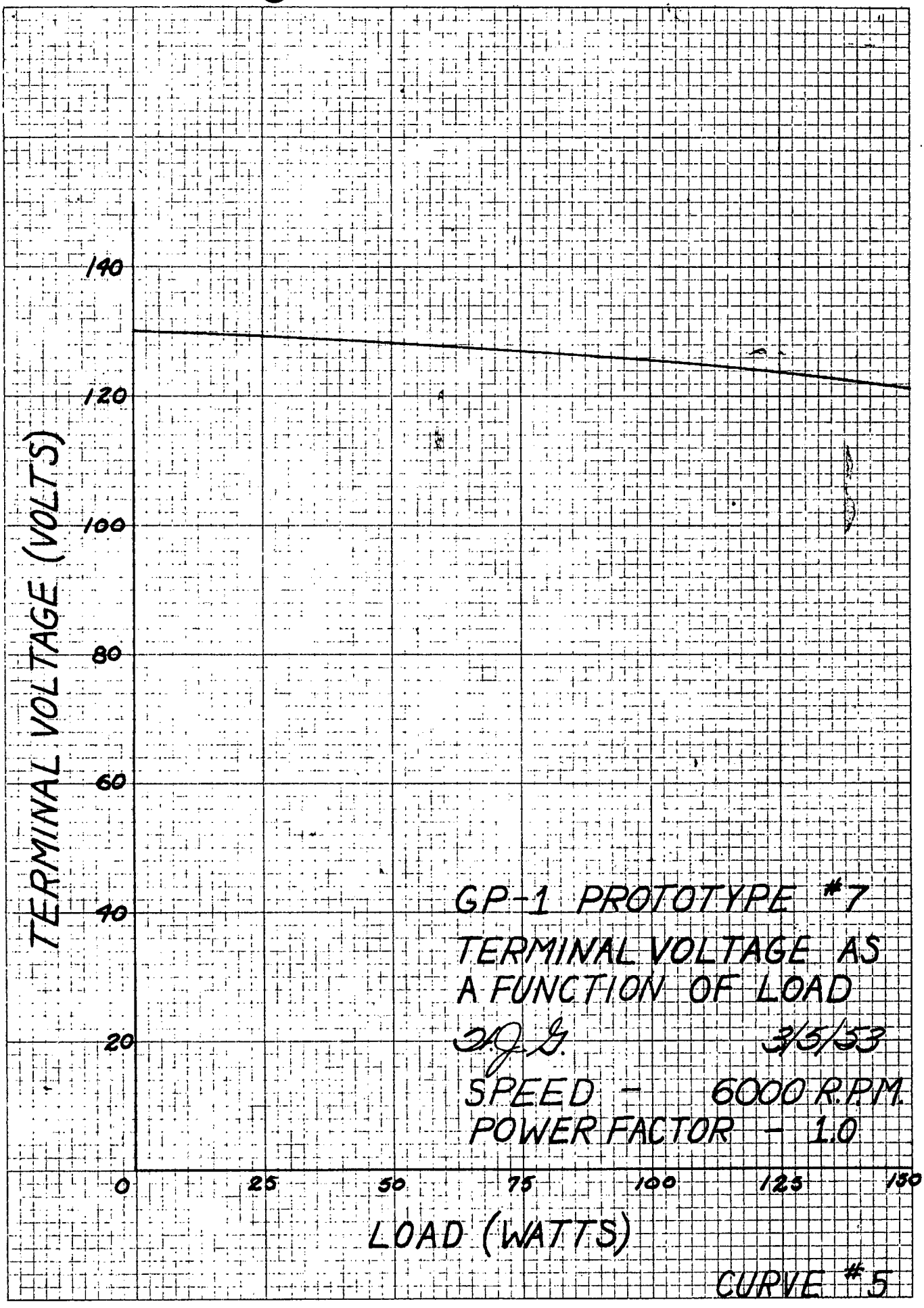
Photograph #5. A view of the impeller assembly showing where the impeller was rubbing against the housing.

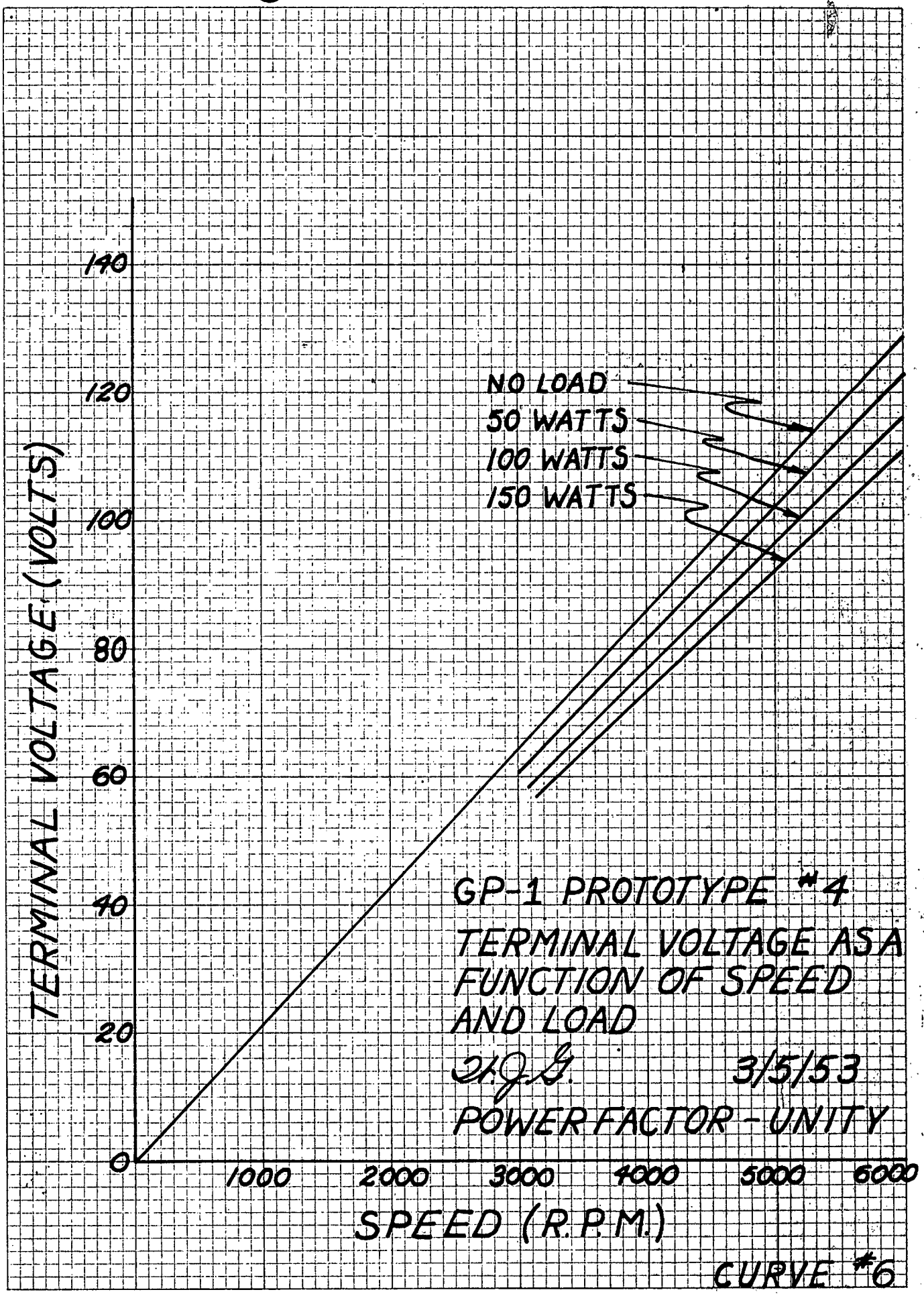


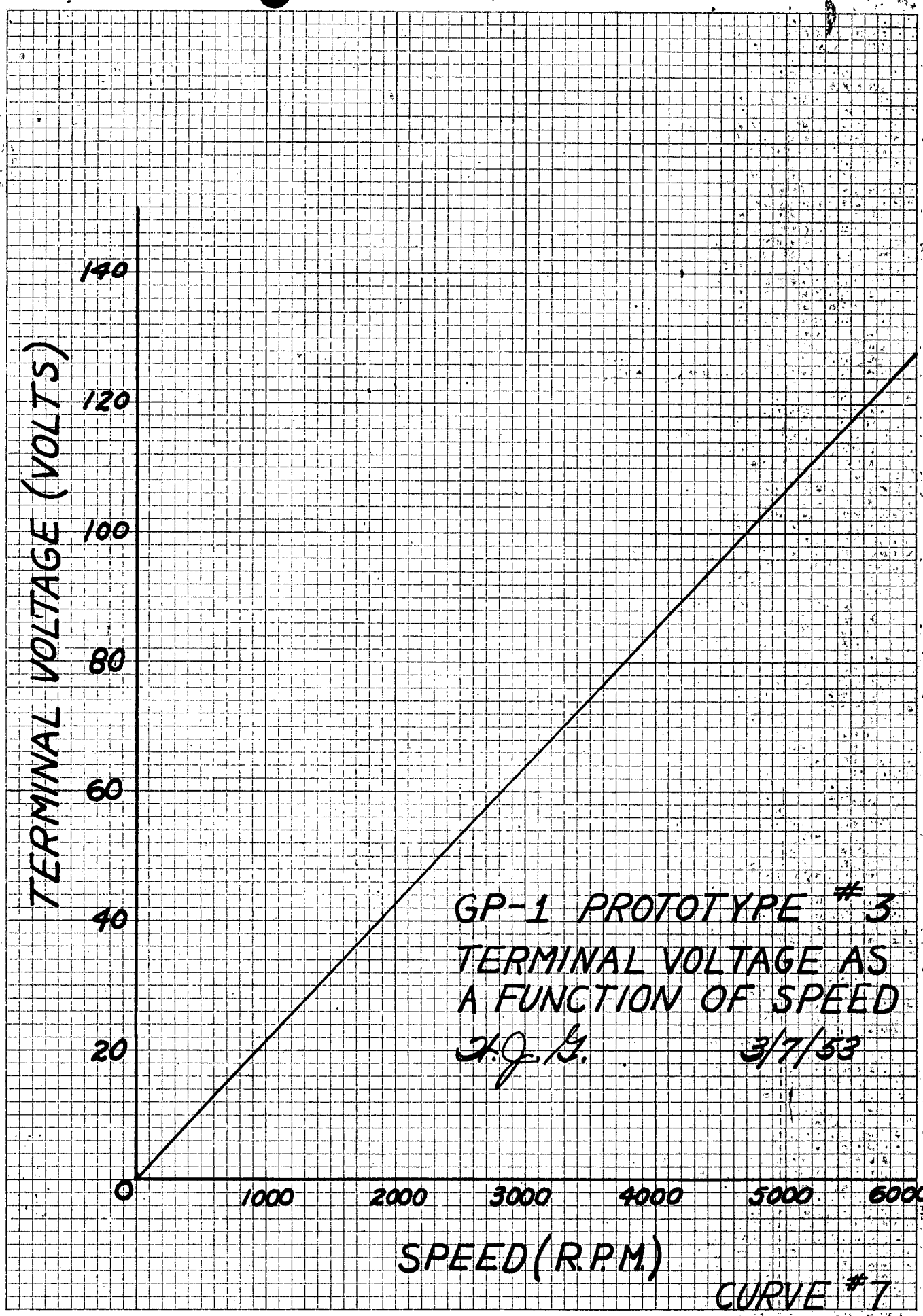


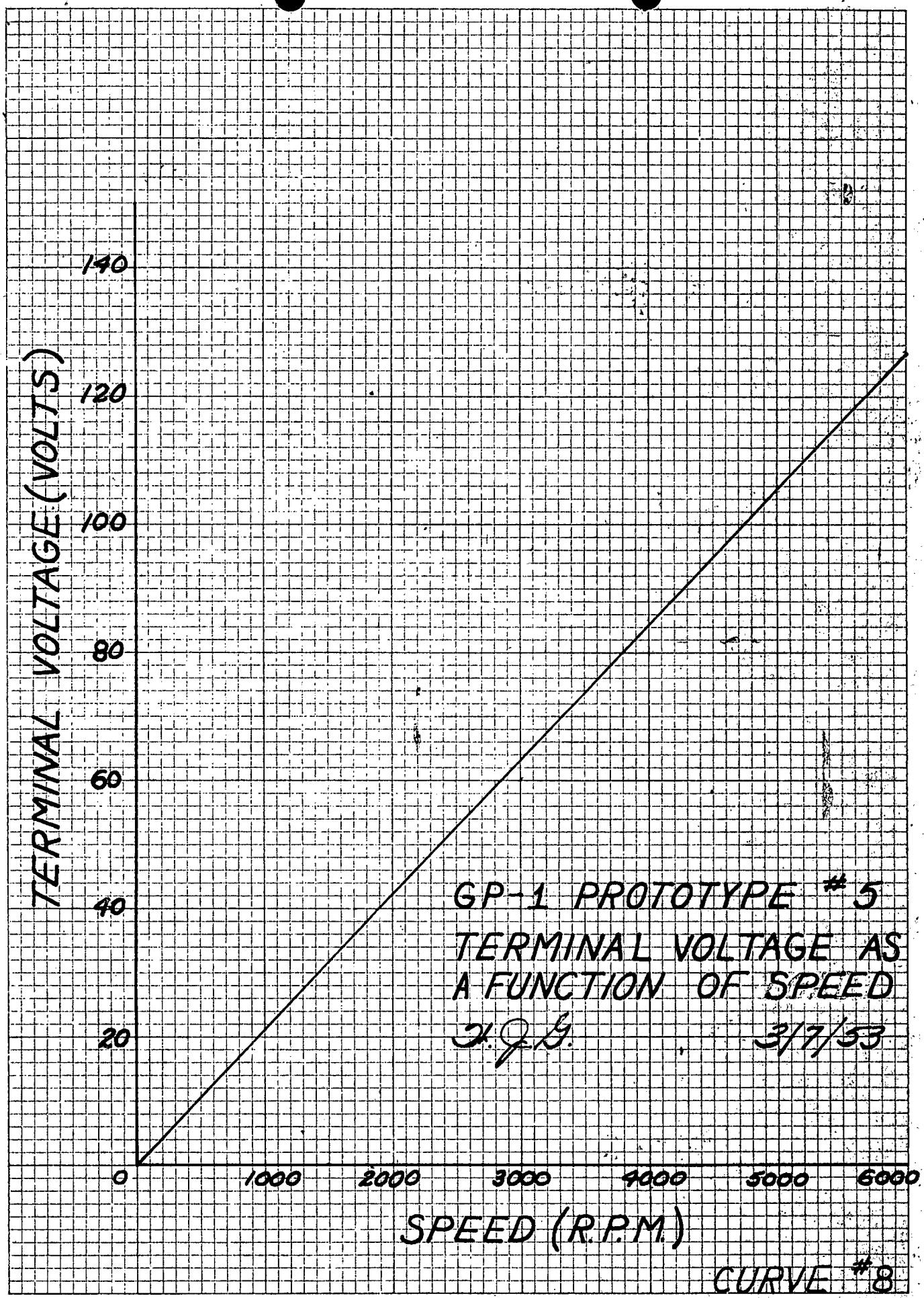


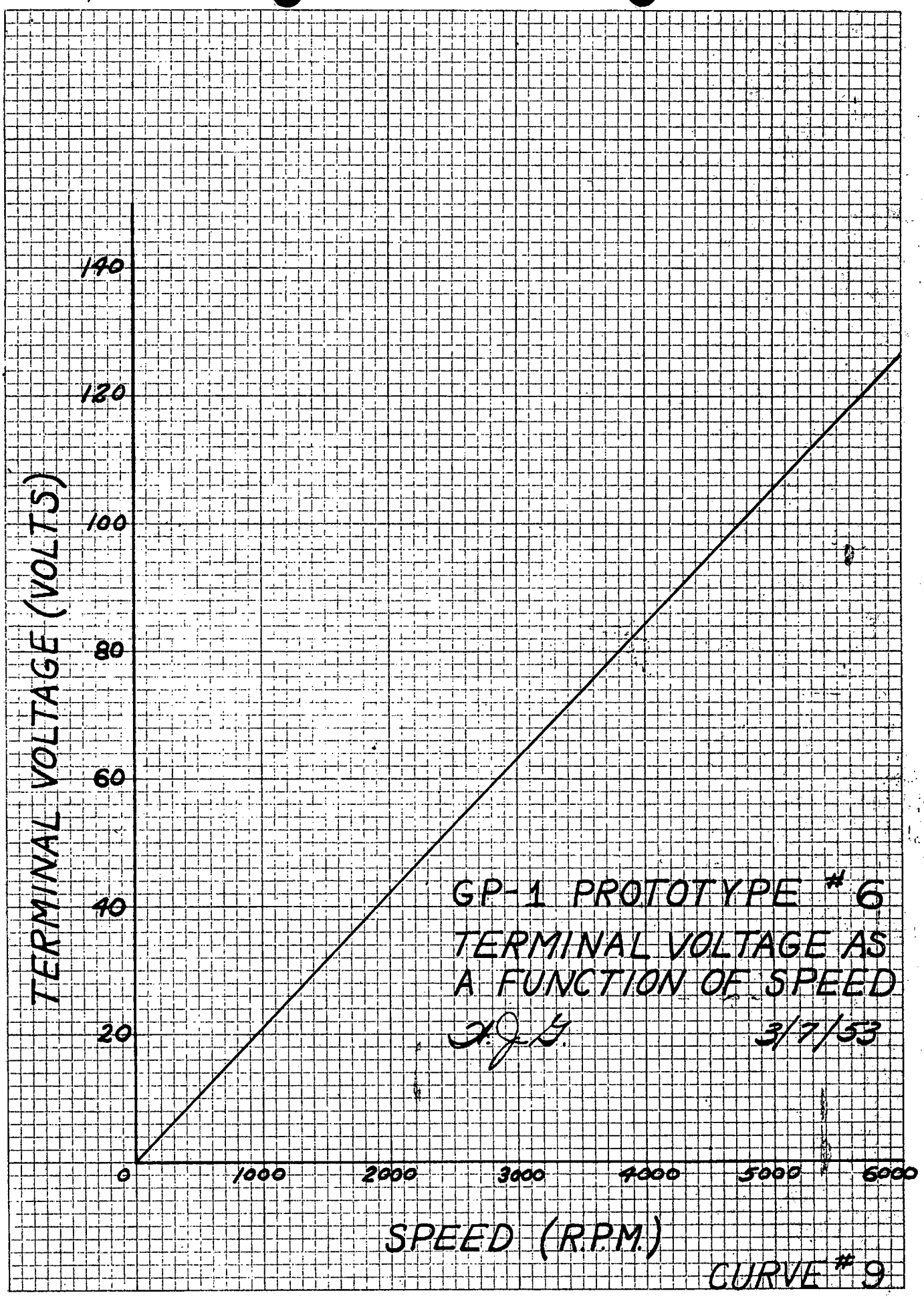


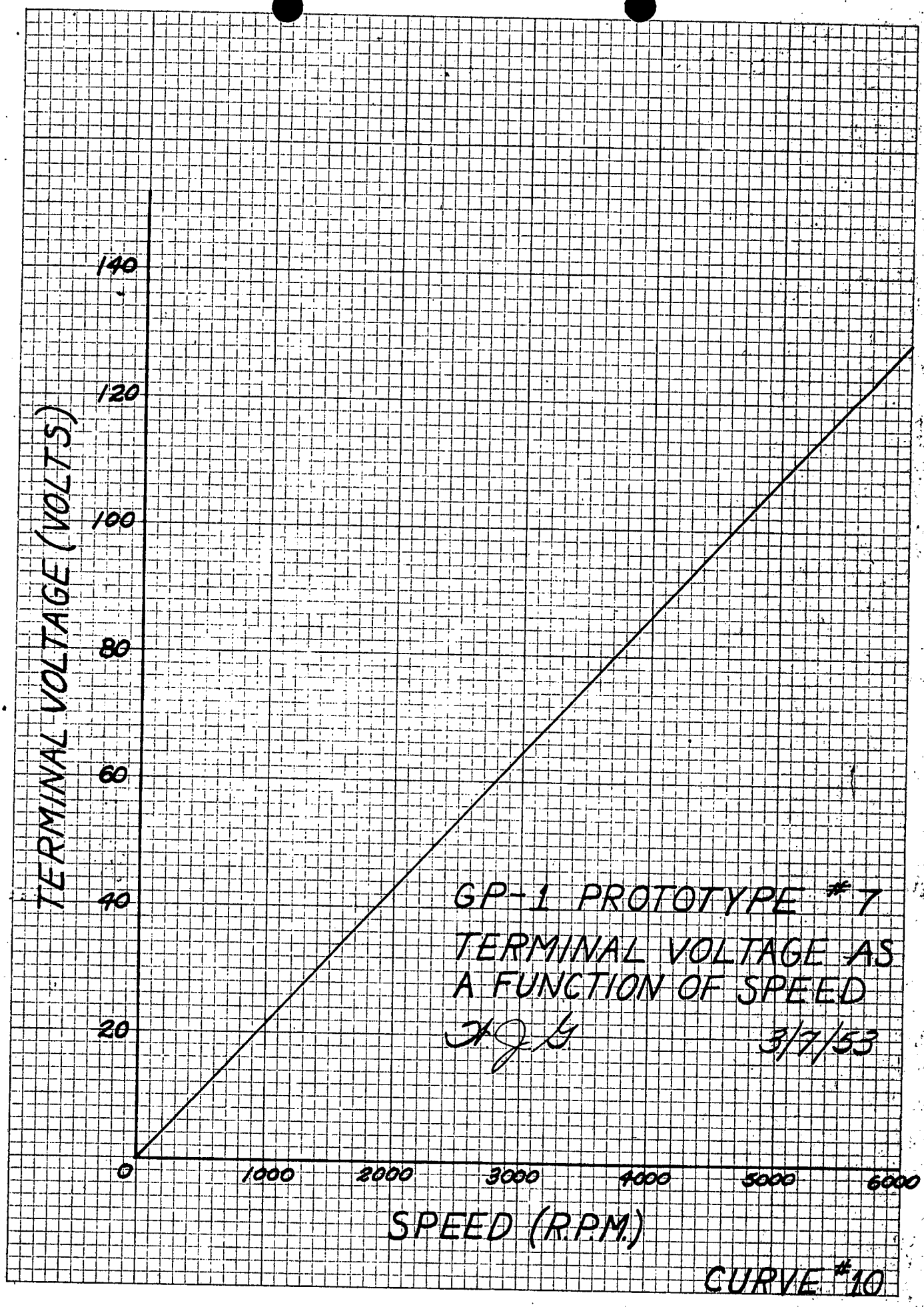


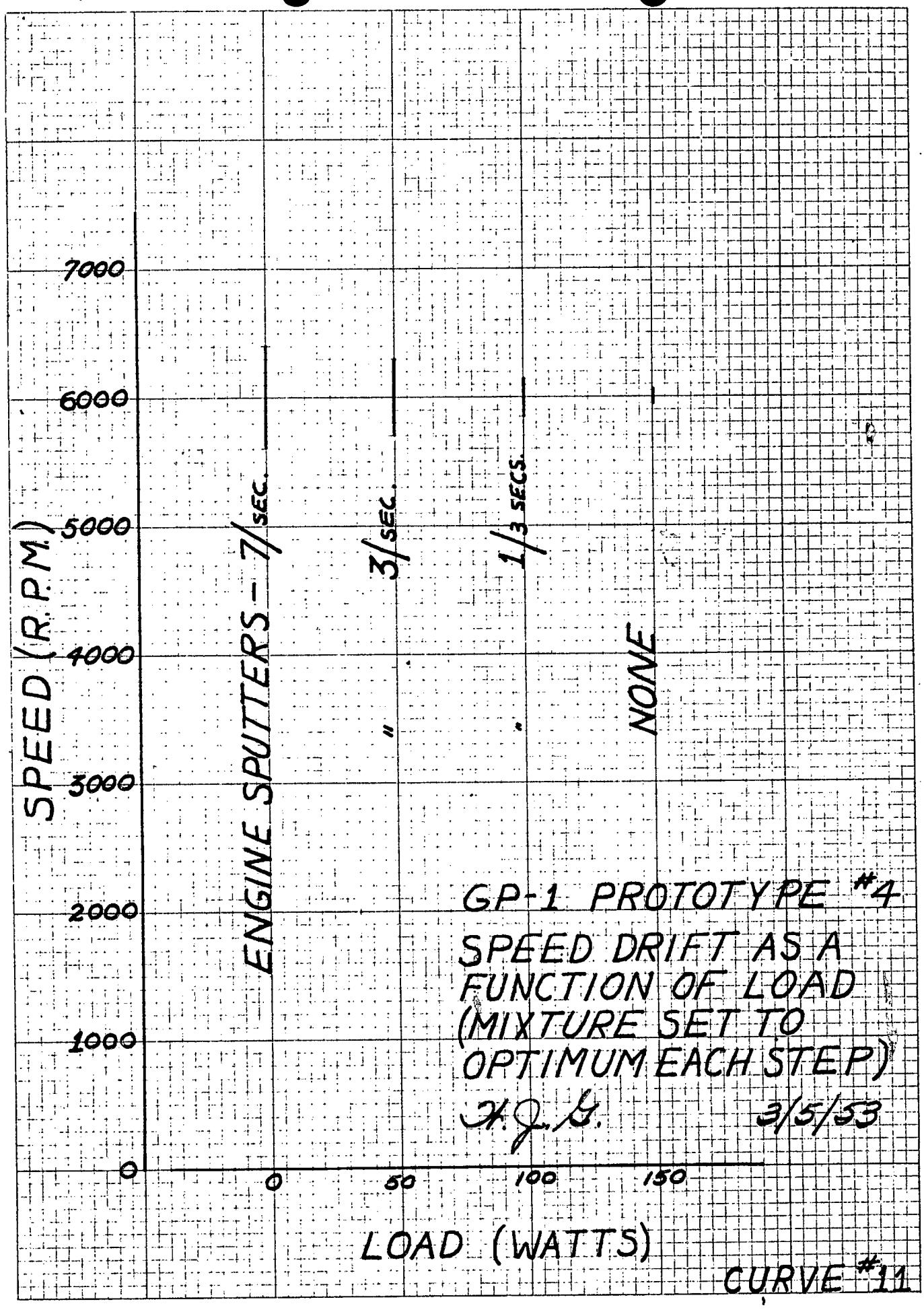


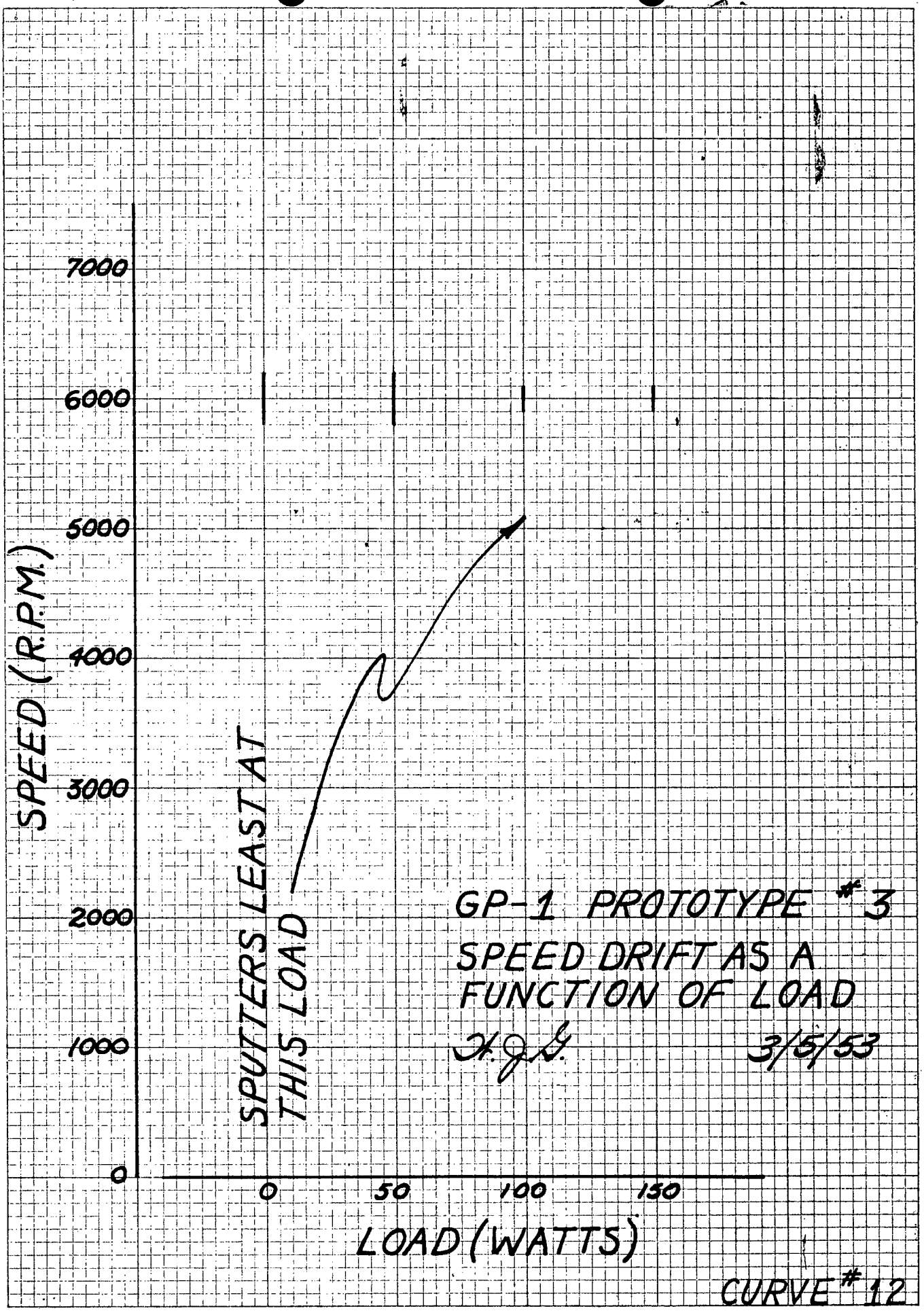


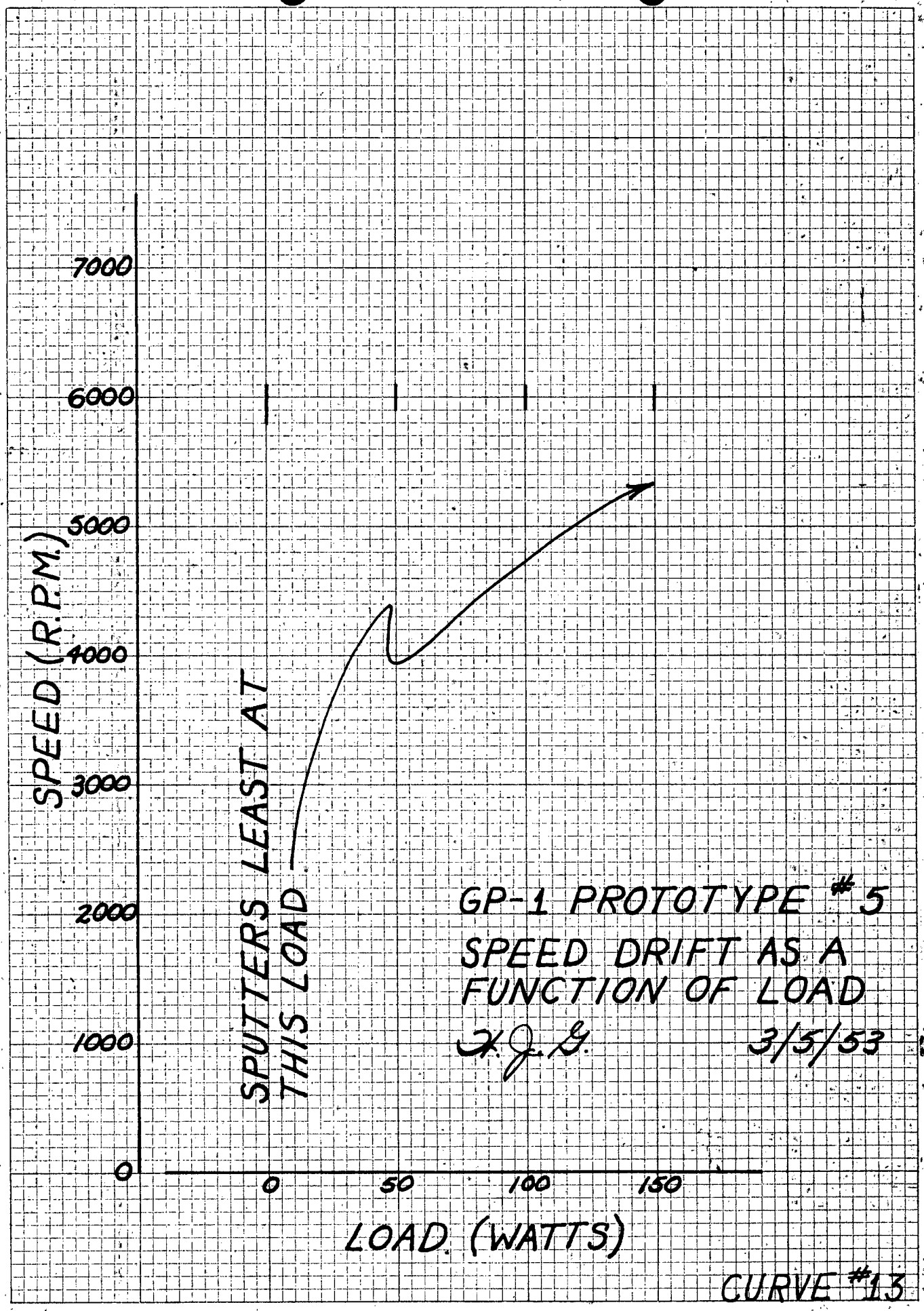


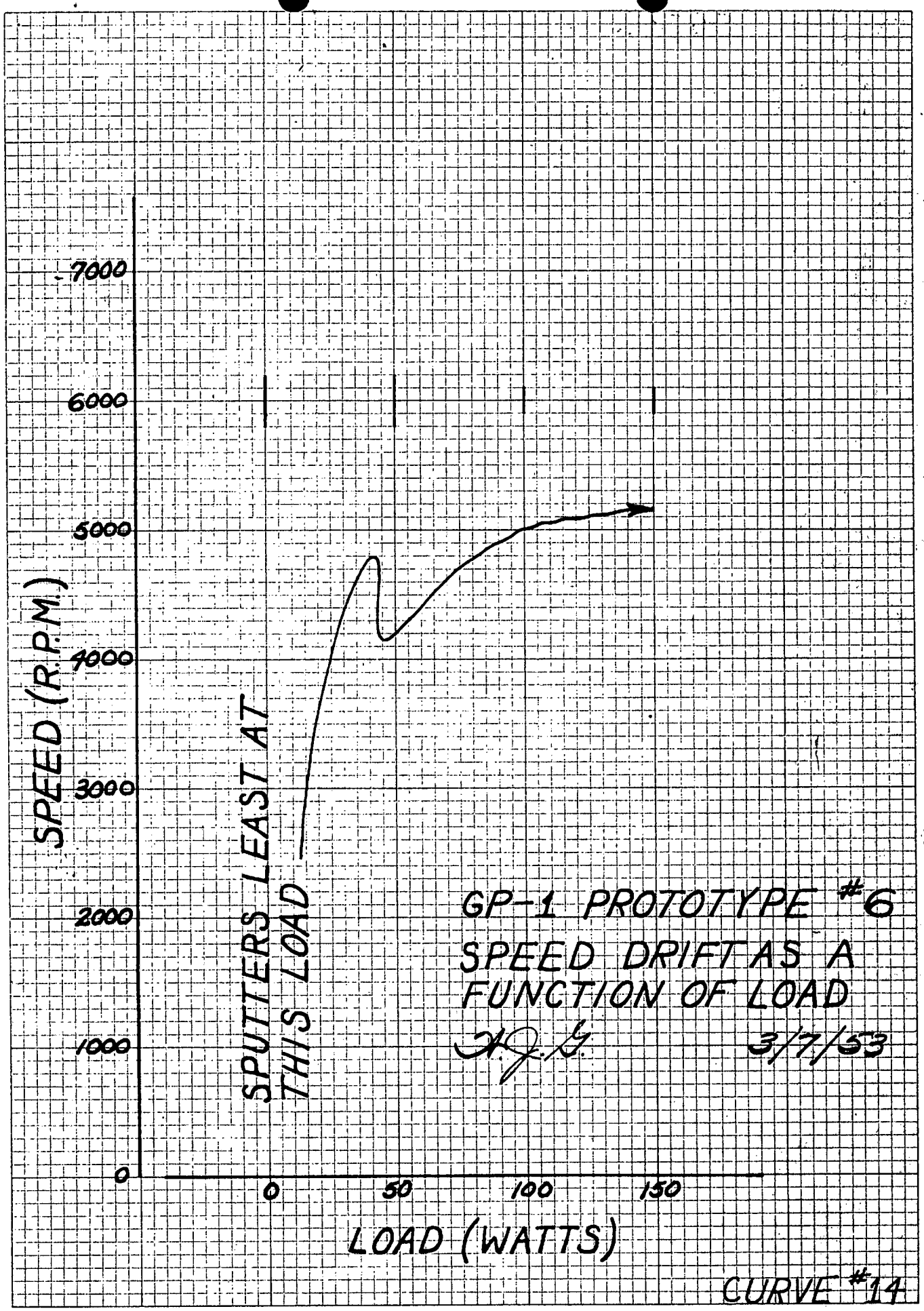


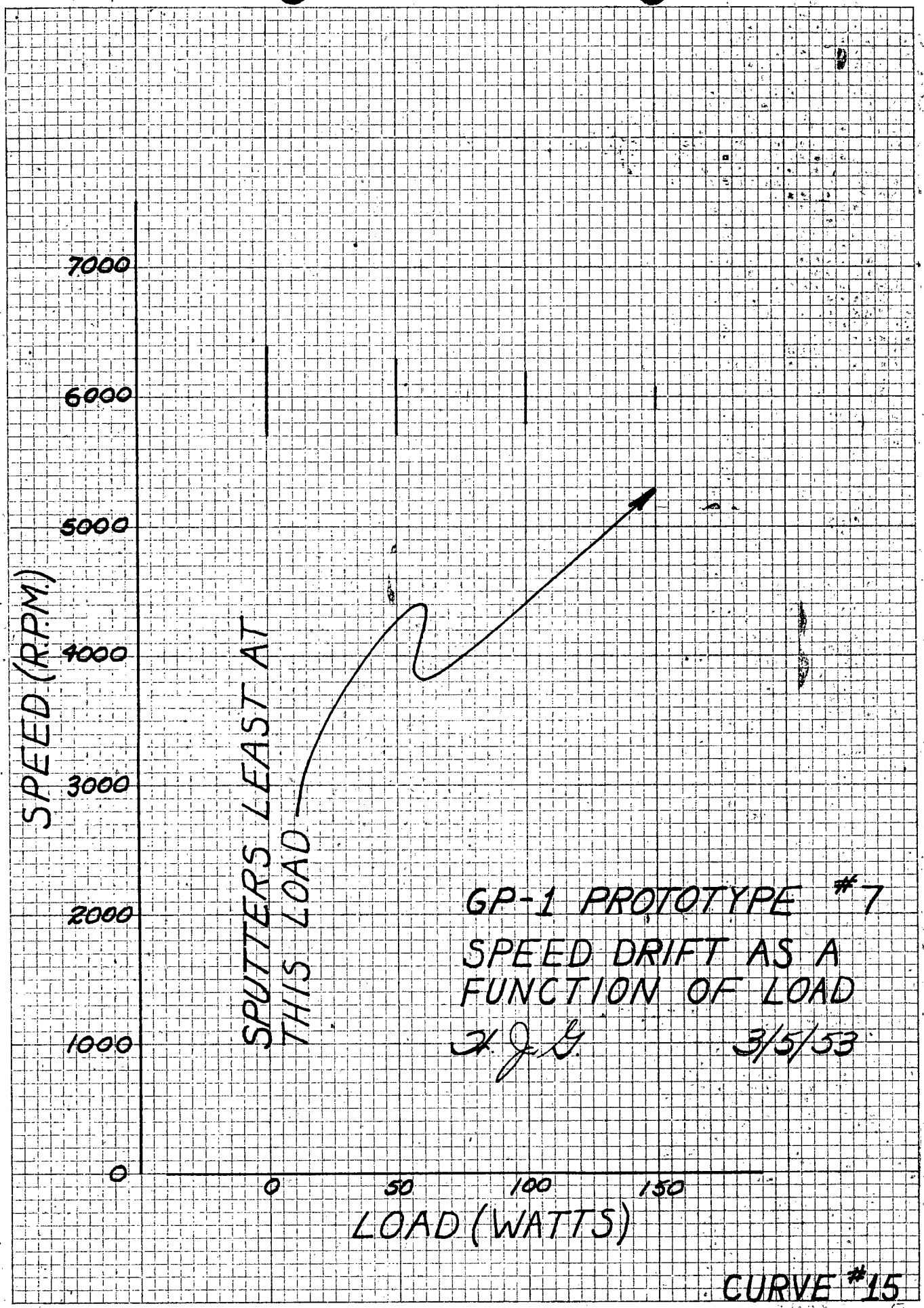


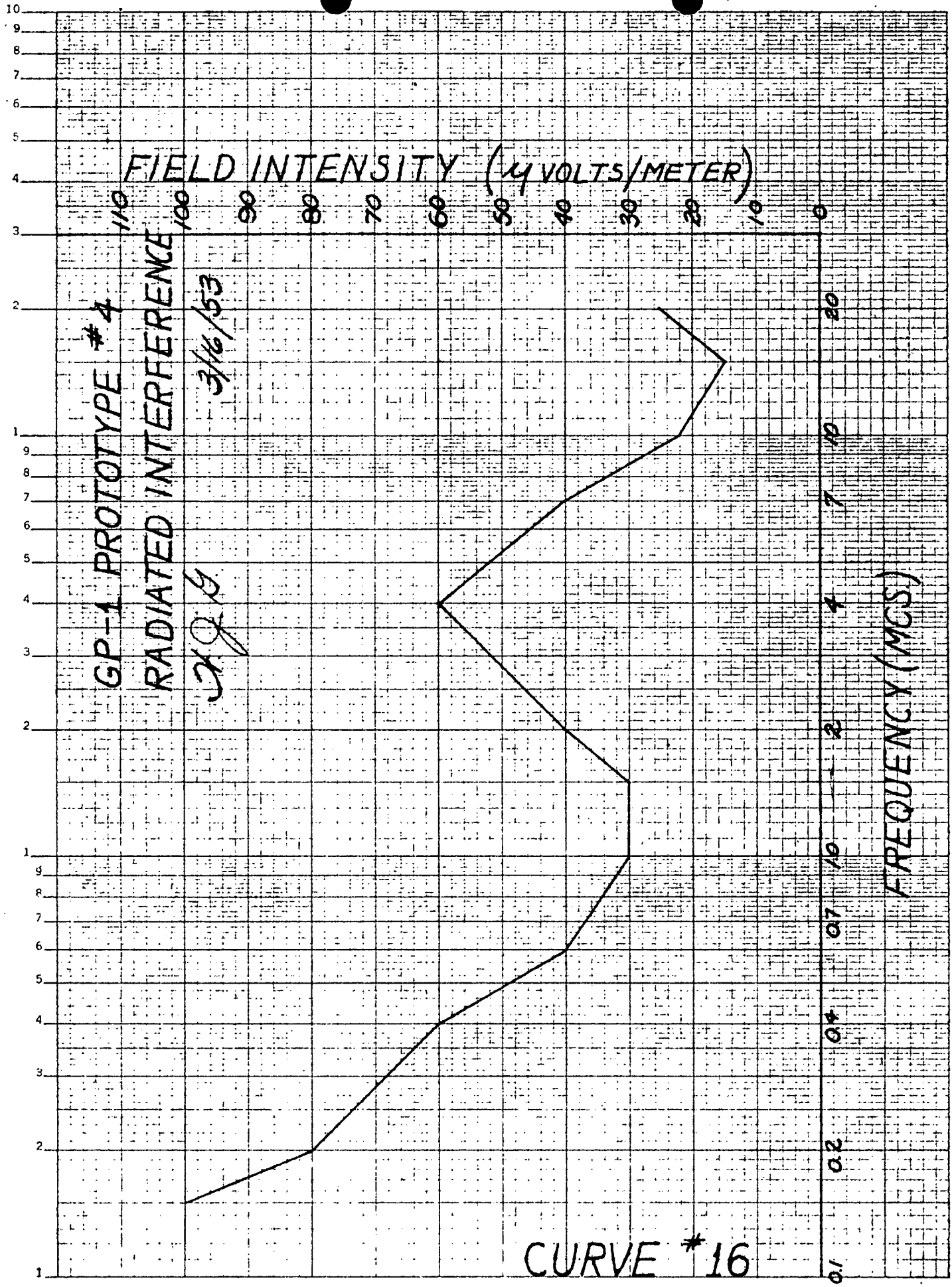












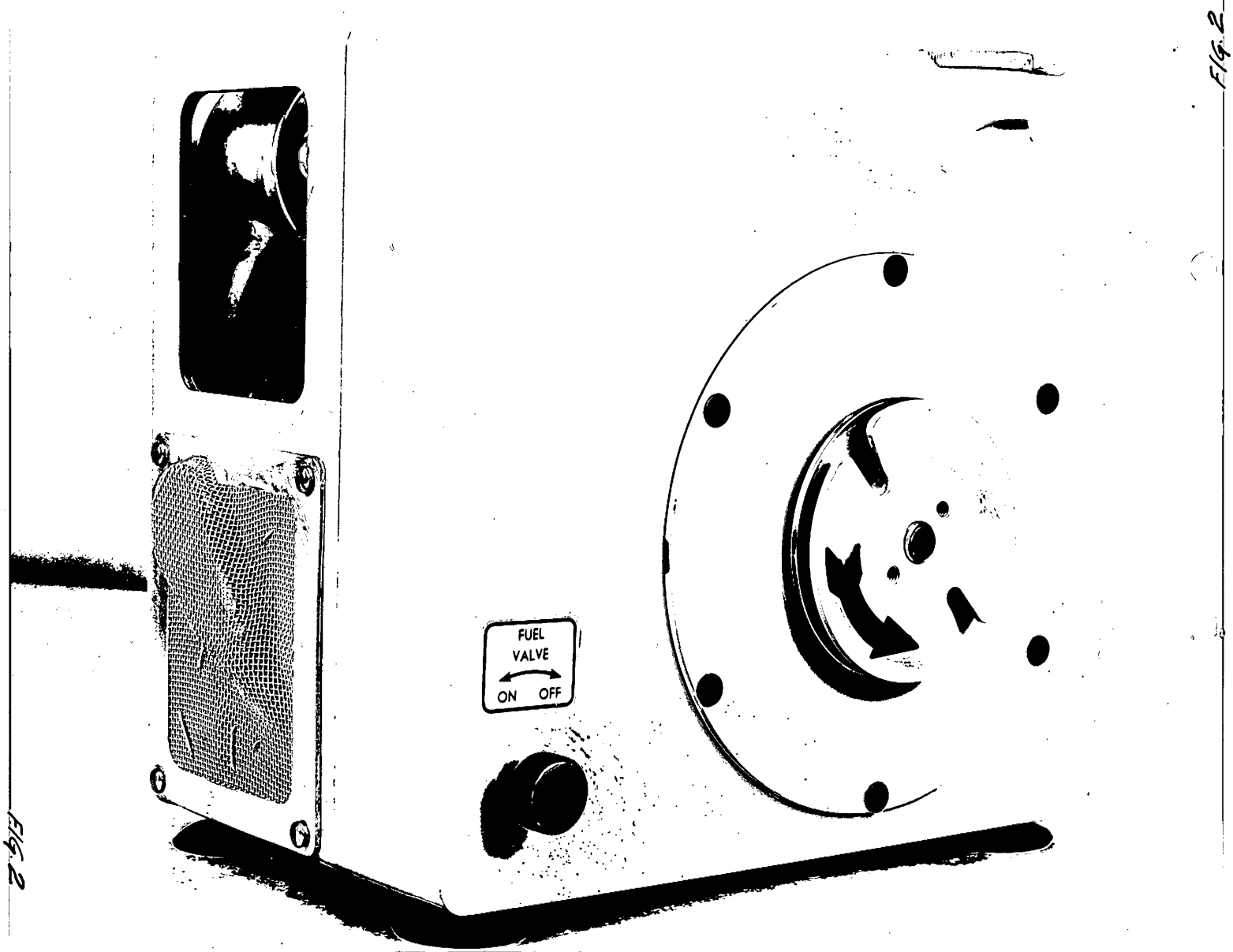


Fig 2

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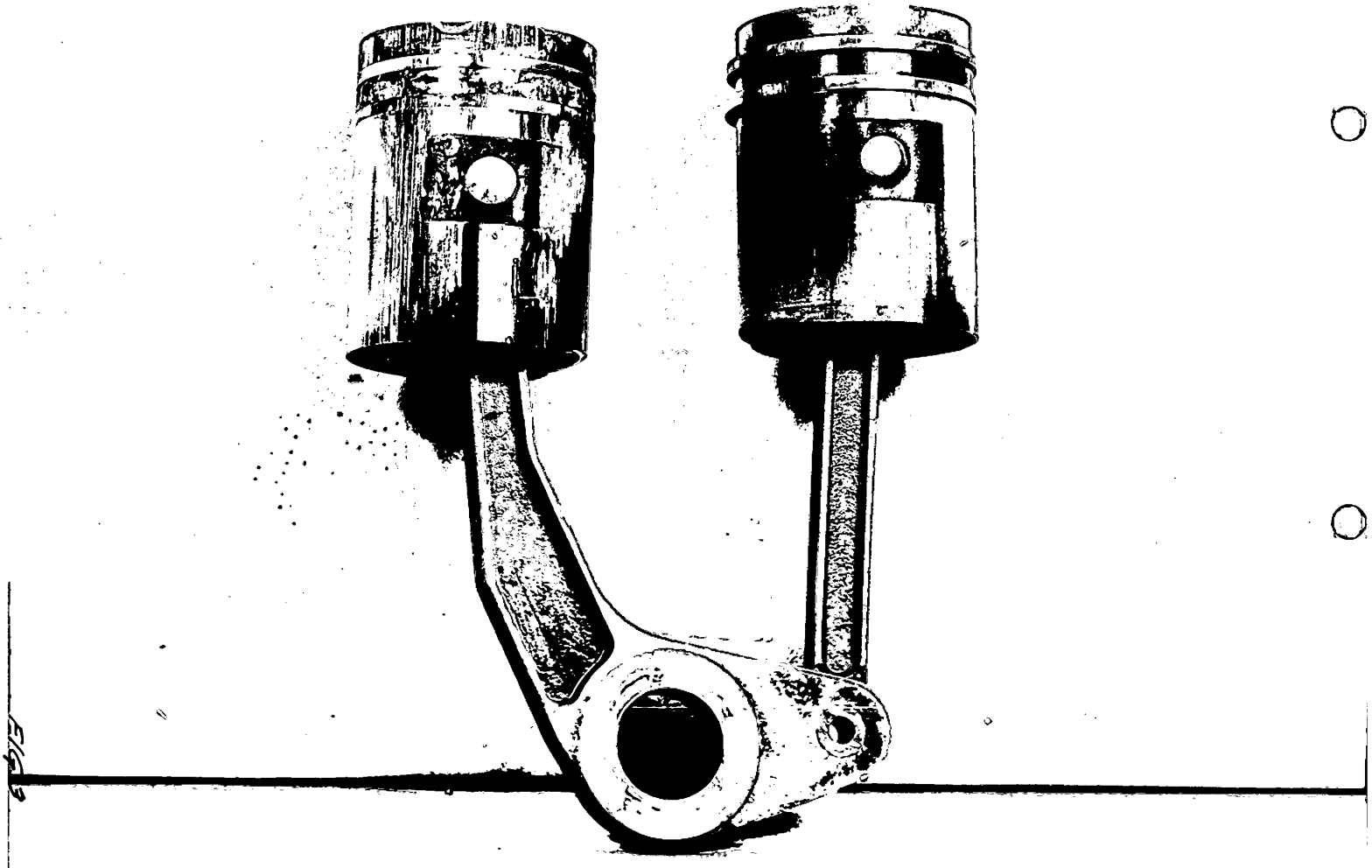
FIG. 3



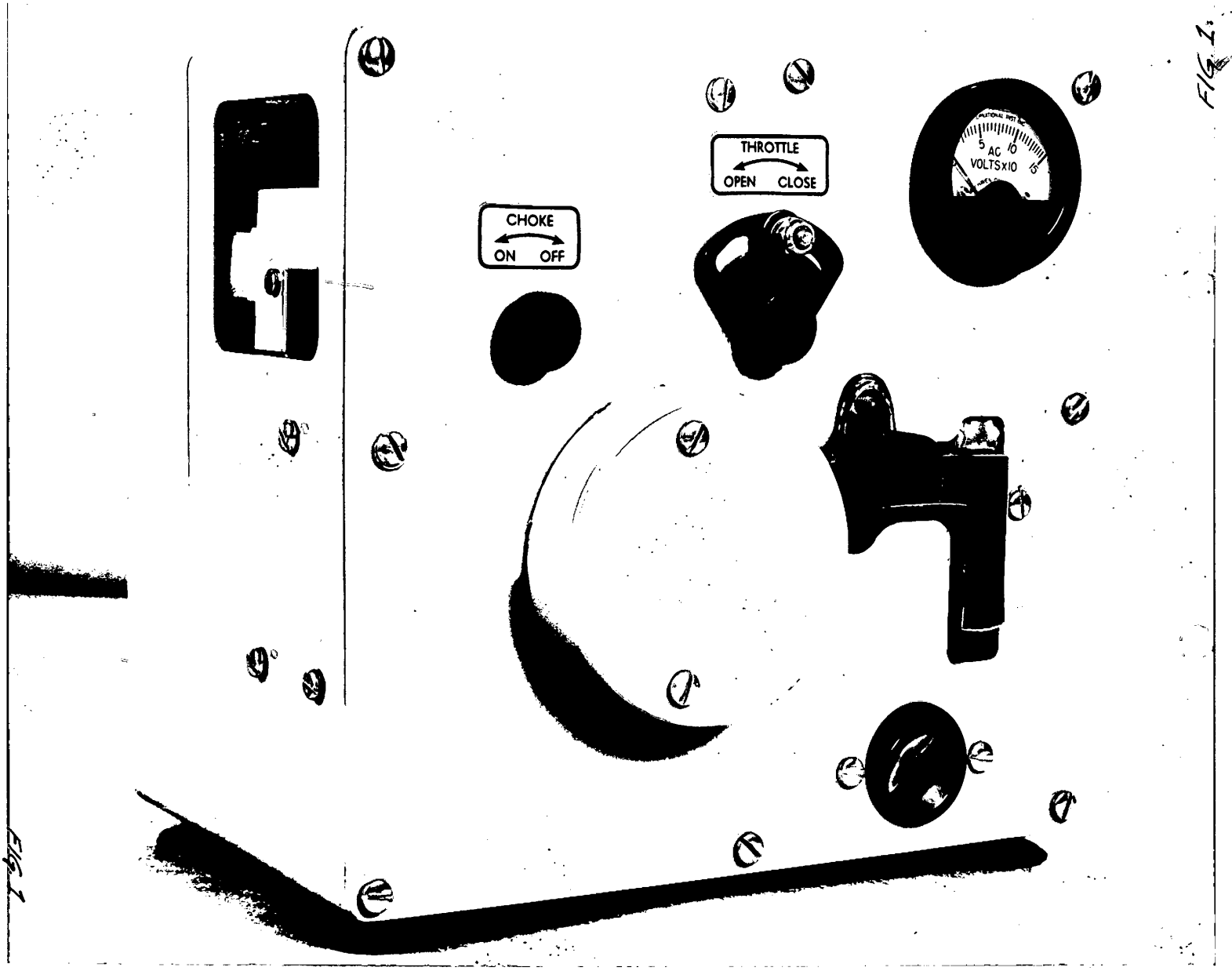


FIG. 1.

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FIG 4

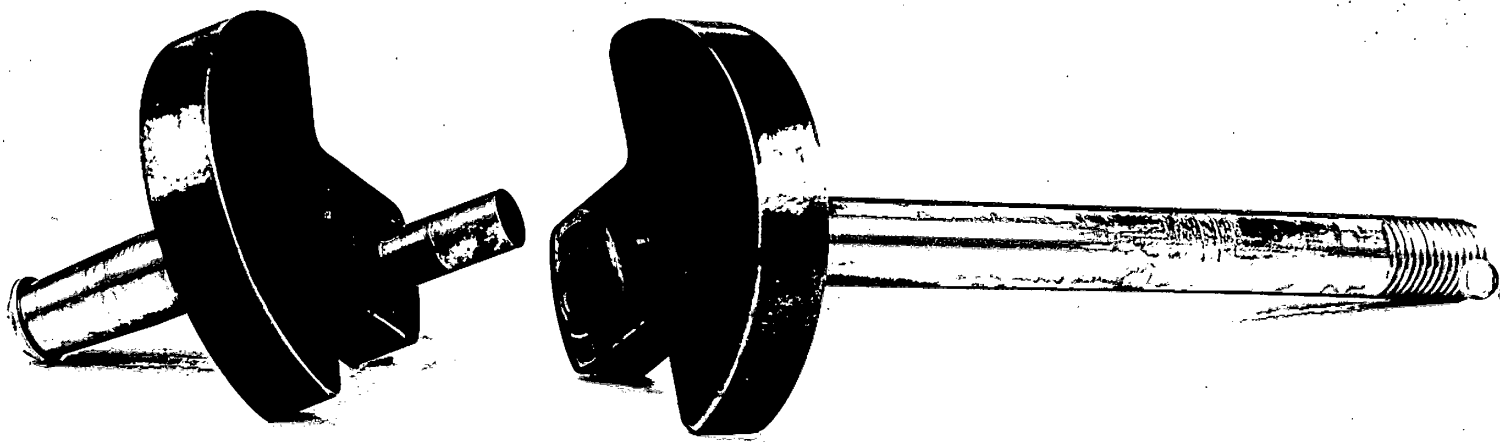
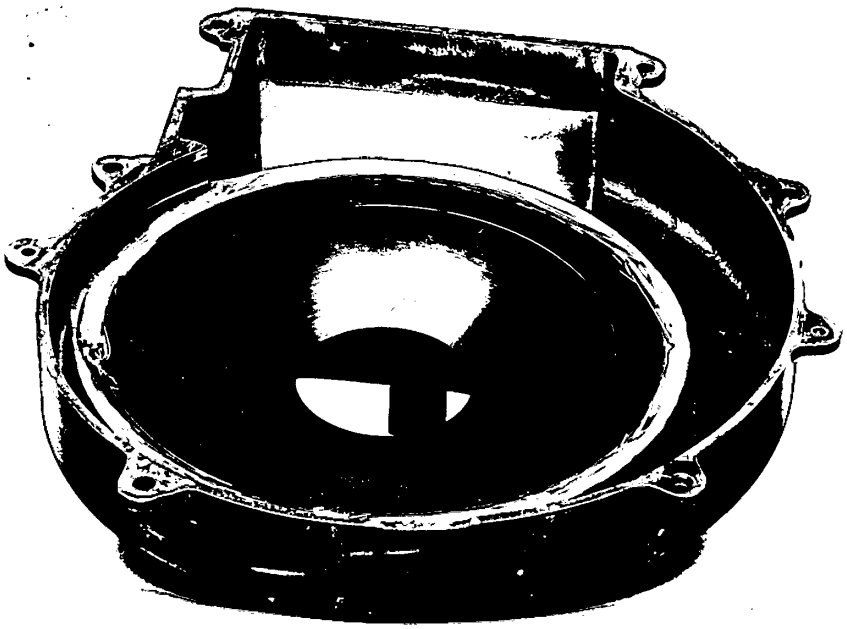


FIG 4

FIG. 5



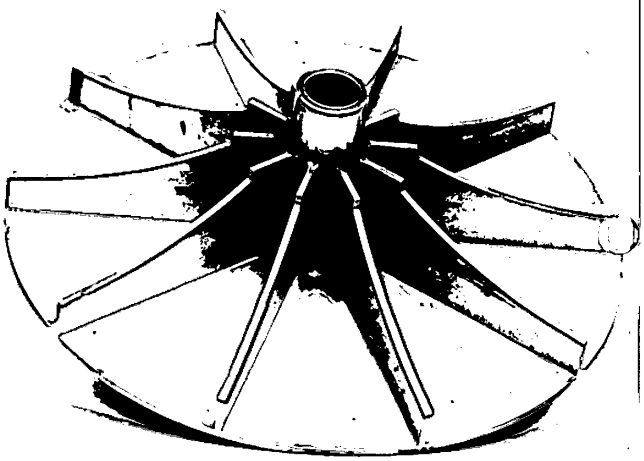


FIG. 5